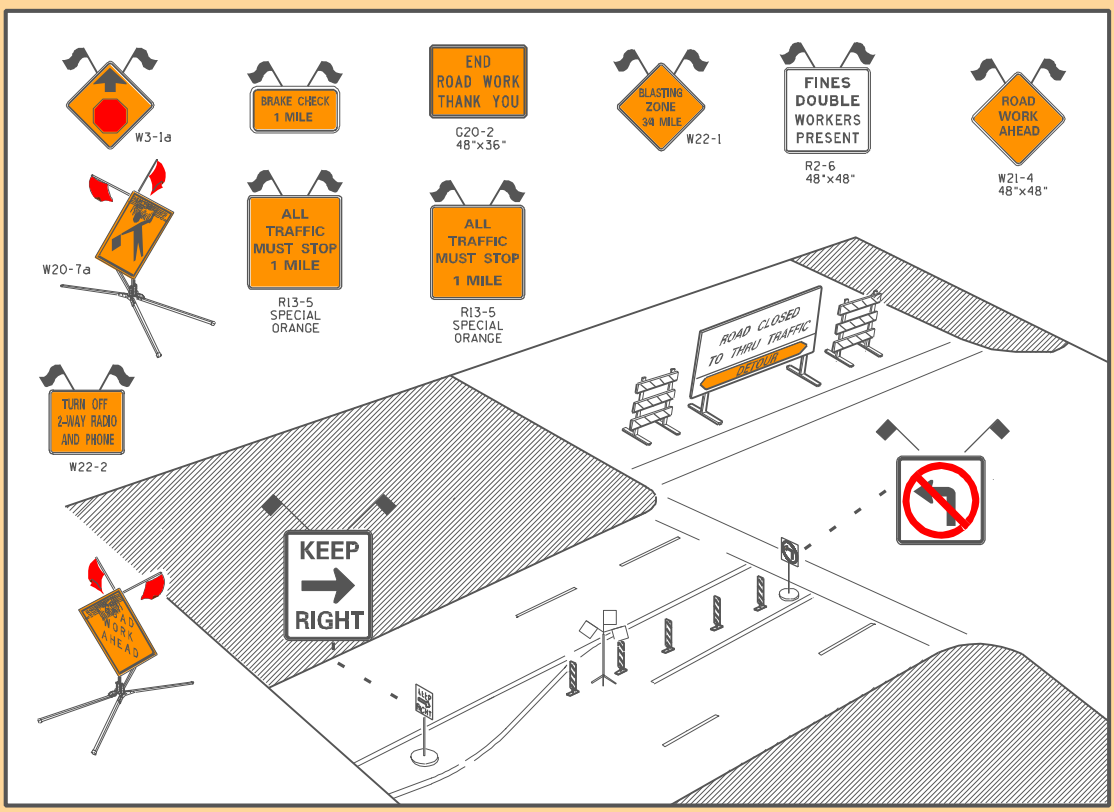
ARIZONA DEPARTMENT OF TRANSPORTATION
TRAFFIC CONTROL DESIGN GUIDELINES
2003

TRAFFIC GROUP

Guides for Design of State Highway System Construction, Maintenance Utility, and Incident Management Operations



31-088

ARIZONA DEPARTMENT OF TRANSPORTATION
GUIDES for DESIGN of TRAFFIC CONTROLS for
STATE HIGHWAY CONSTRUCTION, MAINTENANCE, UTILITY,
and INCIDENT MANAGEMENT OPERATIONS

A INTRODUCTION

This Traffic Control Design Guide is intended to provide design guidelines for the State of Arizona Highway System, and should be used in addition to the MUTCD and not as a stand alone document. Construction, utility and maintenance operations in the State of Arizona are diverse and, in many respects , unique due to vast variations in terrain one is likely to encounter on many projects. From mountain grades and curves to level desert plains, roadway construction and maintenance traffic control requires a tailor–made plan for the terrain encountered. While the MUTCD provides the foundation and the basis for the application and use of traffic control devices, this Design Guide is intended to provide additional guidance to designers, field and maintenance personnel and contractors in establishing and implementing safe, efficient, well conceived traffic control plans. It should be used as an extension of the MUTCD in the day to day implementation of the standards.

It is not the intent of this document to repeat the standards and guidelines already established in the MUTCD, but rather to provide additional information which is applicable specifically to the practices, policies, and procedures currently being implemented on the Arizona State Highway System.

If for any reason, information presented in this document can be interpreted as conflicting with the MUTCD, the interpretation of the MUTCD shall take precedence and govern the design or application of the standard. The Typical Application (TA) Figures, in general, apply to most construction and maintenance projects. Additional Supplemental Application Figures (SA) are provided for those applications which are encountered frequently on State work and are not adequately addressed in the MUTCD.

B FUNDAMENTAL PRINCIPLES

Temporary Traffic control should be based on the design speed of the facility whenever possible. When this is not feasible, the off-peak 85^{tth} percentile speed or posted speed limit prior to construction should govern the design. When a detour road is required to carry traffic around a construction zone, the detour shall be designed in accordance with the standards set forth in ADOT's Construction Standards and speed zoning, signing and pavement markings provided to establish a facility which provides a design comparable to the existing facility.

Depending on the nature and duration of the traffic control needs, a traffic impact study may be appropriate to identify operational changes to accommodate existing vehicular and pedestrian traffic. Areas to consider include roadway capacity, peak hour requirements, traffic signal operation and timing, routing of pedestrians, bicycles and trucks, and emergency vehicle access.

As provided by department directives, the District Engineer or his/her duly authorized representative is empowered and shall have the authority to determine when construction or maintenance activities have progressed to a point where road-way conditions warrant a reduction of speed through all or part of the construction or maintenance project. The necessary speed reduction shall be established in the interest of public safety and convenience and for the protection of workers and equipment through the use of standard speed limit signs placed or caused to be placed by the Arizona Department of Transportation (ADOT).

When a speed reduction greater than 10 mph is considered appropriate, the transition to the lower speed limit should be made in steps of not more than 10 mph. When conditions no longer require a reduction in the speed limit, the signs shall be removed or caused to be removed by ADOT. Documentation as to the reason for reducing the speed limit through a construction or maintenance project shall be maintained.

Standard enhancement to traffic control signing should include flashing warning lights and flags to the sign assembly whenever the traffic control sign is in place overnight or whenever the traffic control is set up during the early morning hours or construction extends into the late evening hours. An exception to this standard is for sections of roadway that are continuously lighted where warning lights will not be required. An additional exception to this standard is for the G20-2 "END ROAD WORK THANK YOU" sign which does not get either the light or the flags. Flags are also omitted from signs set immediately adjacent to the travel way.

C-1 TEMPORARY TRAFFIC CONTROL ELEMENTS

Table ll-1 located in section 2C-3 of the *MUTCD titled A Guide For Advance Warning Sign Placement Distance* should be used when other guidelines are not applicable.

C-2 DEFINITION OF TEMPORARY TRAFFIC CONTROL ZONE COMPONENTS

Advance Warning Area

A minimum of two signs shall be placed in advance of the transition or activity area of the traffic control zone. For divided highways, the advance warning signs shall be located on both the right and left sides of the highway.

C-3 Tapers

When determining the length of taper, speed in the formula is either the design speed, the off-peak 85th percentile speed or the posted speed prior to construction.

When the taper length is a fraction of L, the value of L is based on W, the width of offset relative to the required taper. For example, shoulder taper is 1/3L (minimum) where L is based on the width of the shift. L is further adjusted to the next highest multiple of the spacing of the channelizing device.

C-4 ONE LANE, TWO-WAY TRAFFIC CONTROL

In addition to the Typical Application Traffic Control Figure for the Flagger Method of traffic control, the designer should be aware of the potential for a need to employ the Pilot Car Supplemental Traffic Control Figure SA-3 to augment Flagger control when the Pilot Car Method or traffic control is deemed appropriate.

The Flagger station and pilot vehicle turn around area should be located where these operations are the safest. In rolling or mountainous terrain, the Flagger station and pilot vehicle turn around areas should be located at the top and bottom of the grade. A brake check area should be established in conjunction with the Flagger station at the top of the grade.
Supplemental Application Figure SA-4 represents the Brake Check traffic control requirement.

D TYPES OF DEVICES

D-1 SIGNS

All traffic control signs shall conform first to the design and size of the respective series listed in the ADOT Traffic Engineering Manual of Approved Signs. Signs not in the Manual of Approved Signs shall then conform to Part VI of the MUTCD or other recognized sources for traffic control.

Warning Signs

Warning signs for difference in elevation between travel lane and shoulder should be provided under the following conditions.

(a) LOW SHOULDER Sign (W8-9) – The LOW SHOULDER sign should only be used when the drop off between edge of pavement and shoulder is less than 2 inches.

(b) SHOULDER DROP-OFF Sign (W8-9a) – The SHOULDER DROP-OFF sign should be used when the drop off between the travel lane and the shoulder is 2 inches or more. Furthermore, a fillet of aggregate base material shall be placed adjacent to the drop off at slope o f 3:1 for the protection of run off the road vehicles.

(c) UNEVEN LANES Sign (W8-11) – The UNEVEN LANES sign should be used to identify a difference in elevation between travel lanes of 2 inches or more. These signs should be placed at frequent intervals to warn traffic of the uneven edge between lanes.

D-2 CHANNELIZING DEVICES

General

Spacing of channelizing devices should, as a minimum, comply with the guidelines set forth in the MUTCD.

Typical ADOT practice for highways with design or off-peak 85th percentile speeds of 40 mph or greater prior to construction is to space channelizing devices at 40 feet on tapers and 80 feet on tangent except for cones. The spacing for highways with design or off-peak 85th percentile speeds less than 40 mph prior to construction is the actual speed, in mph, for tapers and twice the actual speed, in mph, for tangent sections.

A flashing warning light shall be placed on each end of each type III barricade whenever the type lII barricade will remain in place overnight or whenever the barricade is set during early morning hours or construction extends into the late evening hours. Steady burning lights shall be placed on every vertical panel, type l and ll barricade and drum during the same periods. The exception to this standard is for sections of roadway that are continuously lighted where neither type of warning light will be required for channelizing devices.

Cones shall be a minimum of 28 inches high for all highway and maintenance operations under high speed traffic conditions of speeds greater than 40 mph

Flexible vertical markers, 36 inches high and 3 inches wide either white or yellow, may be used as a substitute for tubular markers provided they possess the same retroreflective qualities.

Portable Barriers

Portable barriers (Temporary Concrete Barrier) shall be designed in accordance with ADOT adopted design standards following the Length of Need and Offset formulas found in Chapter 5 of the Roadside Design Guide (RDG). The flare rate to be used in the Length of Need Formula shall be taken from Table 9.1, found in Chapter 9 of the RDG. In addition, determination of clear zone protection shall be based on the guidelines set forth in Chapter 3 of the RDG. Appendix A of this Design Guideline provides excerpts of the Chapters of the Roadside Design Guide identified herein to lay out Temporary Concrete Barrier.

D-3 MARKINGS

Temporary (interim) striping or pavement markings should be installed at the end of each day of work on roadway segments where the existing markings have been obliterated or covered leaving the roadway unmarked overnight. At a minimum, center lines, lane lines, no passing zones, channelized areas, special markings such as railroad crossings, and stop bar locations should be installed.

Interim Markings

Interim markings are divided into two categories. The first category describes marking requirements during construction where additional work will be performed on the roadway before the project is complete. An example of this category is a project which has several layers of paving requiring markings to be placed on each subsequent pavement layer.

The second category describes marking requirements for a project which has been completed but final marking cannot be installed due to weather, temperature or scheduling issues.

For the first category, the interim marking section of Part VI of the MUTCD shall apply. In general, minimum markings to be installed for up to a two week period should be the 4 foot stripe over a 40 foot distance (2 foot stripe over a 20 foot distance) for center lines and lane lines and special markings and stop bars. If the interim period is to be longer than two weeks before any additional work is to be done on the roadway, full centerline and lane line striping would be required in addition to special markings and stop bars. In addition, gore and edge lines should be considered on freeway and high speed multi-lane highways.

For the second category, the roadway shall be fully striped in accordance with the permanent pavement marking plan except that turn lane “only” legend may be omitted.

Temporary Pavement Markers may be used to delineate the center line or lane line for both categories when they will be in place for two weeks or less. Any markings needed for more that two weeks shall be either paint or preformed plastic pavement markings.

Delineators

Delineator placement and spacing shall be determined in accordance with ADOT Standard Drawings.

D-4 OTHER DEVICES

Portable Barriers

The effect of striking the ends of barriers should be mitigated by the use of an impact attenuator, placing the end of the barrier through and existing guard rail section, or abutting the end against or into the side of an embankment. The end of the barrier need not be protected if the end is located outside the clear zone.

E TYPES OF TEMPORARY TRAFFIC CONTROL ZONE ACTIVITIES

E-1 SELECTING THE TYPICAL APPLICATION

a. Duration of Work

For certain work zone conditions, work duration for the purpose of selecting an appropriate typical traffic control layout or setup is not relevant. Generally, when the work activity creates a drop off of greater than 2 inches adjacent to the travel way which cannot be mitigated with a fillet of material, Temporary Concrete Barrier protection should be provided upon creation of the condition, irrespective of the actual duration of the work activity.

b. Long-Term Stationary

In general, stationary work activity of one week or more is considered long term for the purpose of temporarily altering the existing pavement markings by obliterating the existing pavement markings and developing a semi-permanent traffic control pavement marking plan. For work in an urban area where the operating speeds are relatively low, generally 35 mph (56 km/h) or lower, channelization would be developed entirely through channelizing devices without changes in the permanent pavement markings unless the existing markings create undue confusion in the intended operation of the traffic control plan. Lane closure channelization layouts as shown in Typical Application Figures TA-21 through TA-28 as well as Supplemental Application Figures SA-6 through SA-8 are examples of work zones where a long term traffic control set-up may or may not require changes in permanent markings.

E-2 WORK OUTSIDE THE SHOULDER

Supplemental Application Figure SA-1 depicts a typical blasting zone traffic control plan for rural or arterial two lane or multi-lane highways. All blasting and rock

scaling activities require full road closures adjacent to the blasting site or scaling operation at the time of the blasting or scaling activity. Advance warning signage is extremely important to forewarn motorists of the time and duration of the delay and advise on alternative routing, if appropriate.

E-3 WORK WITHIN TRAVELED WAY-RURAL TWO LANE

a. Detours

Supplemental Application Figure SA-2 depicts required through, right, and left turn lane closures for a full road closure on the departure side of the intersection. If local traffic is allowed into the closed roadway, the appropriate signage and barricading must be added to these figures.

b. One-Way Traffic Control

Pilot Car Method – Supplemental Application Figure SA-3 depicts a typical pilot car traffic control plan as an enhancement to Typical Application TA-10, Flagger Traffic Control. Supplemental Application Figure SA-4 depicts a Brake Check Area frequently needed as part of Flagger or Pilot Vehicle traffic control on projects where the terrain is rolling or mountainous.

E-4 WORK WITHIN TRAVELED WAY-RURAL OR URBAN, MULTI-LANE DIVIDED AND UNDIVIDED, NONACCESS CONTROLLED

Lane Closure or Lane and a Half Closure – Right or Left Lanes

Supplemental Application Figure SA-5 depicts a typical lane closure with a partial lane shift for freeway or divided multi-lane highways with shoulders on both sides of the traveled way. This application is used when work within the lane extends up to the center line of the roadway with the potential for equipment and workers to encroach onto the adjacent travel lane. For a divided multi-lane highway with less than a 10 foot shoulder adjacent to the right lane and a 4 foot shoulder adjacent to the left lane, considerable care must be exercised in developing a travel lane with a minimum width of 10 feet without lateral constraint and 11 feet with lateral constraint. Police officer control may be needed to reduce the speed throughout the constrained area.

Supplemental Application Figure SA-5 is applicable as well for a lane closure where a shift is not needed adjacent to the work zone.

Supplemental Application Figure SA-12 depicts traffic control in the "Fines are double in the work zone where workers are present" configuration.

E-5 WORK WITHIN TRAVELED WAY-INTERSECTIONS

Supplemental Application Figure SA-6 depicts work on the approach side of the intersection requiring the use of the left turn lane for through traffic with appropriate left turn prohibition.

Supplemental Application Figure SA-7 depicts work in the right through lane on the approach side of the intersection with channelization shifting traffic into adjacent lanes through the intersection with appropriate left turn prohibition.

Supplemental Application Figure SA-8 depicts work in the right through lane on the approach side of the intersection with channelization shifting the right through lane into the right turn lane with appropriate right turn prohibition.

a. Problem Areas – Rural

The most prevalent problem associated with work within the traveled way on rural freeway segments is the lack of interchanges and the lack of alternate routes off the freeway for detouring traffic. In variably, all work must be performed with traffic routed to some segment of the existing freeway. For single lane closures, traffic is frequently shifted around the work area onto the shoulders as depicted in Supplemental Application Figure SA-5. For full closures in one direction, traffic is routed to the opposing lanes by way of a median crossover. The gore areas of the median crossover and the high speed two-way operation introduces safety concerns which should be considered in the development and implementation of the traffic control plan.

Traffic Engineering must take a proactive role in the design of the traffic detour and the median crossover as suggested in the MUTCD.

a. Problem Areas – Urban

The most prevalent problem with work within the travel lanes within the urban areas is high traffic volumes. This condition usually dictates that any work requiring a lane closure be performed at night when traffic is at its lowest volume. For multiple lane closures, a full freeway closure should be

considered with all traffic exiting the freeway onto the local arterial street system. A detailed detour plan should be developed and discussed with the local jurisdiction(s) for approval. Supplemental Application Figure SA-9 depicts the traffic control requirements for a full freeway closure.

b. Crossovers

In addition to the implementation of Figure TA-39, consideration should be given to the installation of Temporary Concrete Barrier (TCB) within the gore areas and along the full length of the two-way section with appropriate end section attenuation. In addition to the TCB, a glare screen should be considered, especially where vehicle headlights aim directly at opposing traffic.

c. Interchanges

When an interchange is going to be closed for a period of time to perform work within it, advance notification and alternate routing should be an integral part of the traffic control plan. Once the date of the closure has been determined, the advance notification should be displayed for at least one week to inform all users of the impending inconvenience. Supplemental Application Figure SA-10 depicts the proper advance notification and the signing and traffic control to be employed at the time of the closure. Advance notification can be developed through permanent signing or a variable message sign.

d. Median Crossover

For construction activities on a multi-lane limited access divided highway or freeway where the interchanges are several miles apart, it may be advantageous to develop and use median crossovers to allow construction vehicles to get from one side of the freeway to the other. The deceleration lane in advance of the crossover and the acceleration lane onto the freeway shall be protected by closing each lane to freeway traffic as shown on Supplemental Application Figure SA-11.

F APPLICATION OF DEVICES

F-2 SUPPLEMENTAL APPLICATION

In addition to the typical applications found in Part VI, ADOT Construction and Maintenance consistently uses several additional typical traffic control applications for various types of work activities. These typical applications are added to Part VI and are labeled as Supplemental Application Figures SA-1 through SA-12.

F-3 GENERAL NOTES

a. Work Performed on the Roadside (Outside Shoulder)

Many projects require rock scaling or blasting either to improve safety within the right-of-way or for the purpose of widening the roadway section for adding through or auxiliary traffic lanes. Supplemental Application Figure SA-1 should be used as a guide for the times when blasting is a part of the project activity. The most important aspect of the Blasting Zone traffic control is the advance signing and advance notification of the time and dates of intended roadway closures so that the motoring public is adequately informed on the amount of delay they can expect and to provide alternate routing, if available. In many instances, uniformed police officers are used in conjunction with Figure SA-1 especially if the blasting takes place at night during very light traffic volume periods.

b. Lane Closings on Multilane Roads

The Lane and a Half Supplemental Application Figures SA-5(L) and SA-5(R) should be used on all construction activities where it is necessary to first channel traffic out of one of the through lanes and then to shift the traffic onto the shoulder adjacent to the work zone to provide added protection to the workers without unduly constraining traffic operations. This application is most commonly used for roadway paving, concrete slab pavement removal and replacement, open trench underground construction across the roadway, and other activities where the work zone extends right up to the roadway centerline.

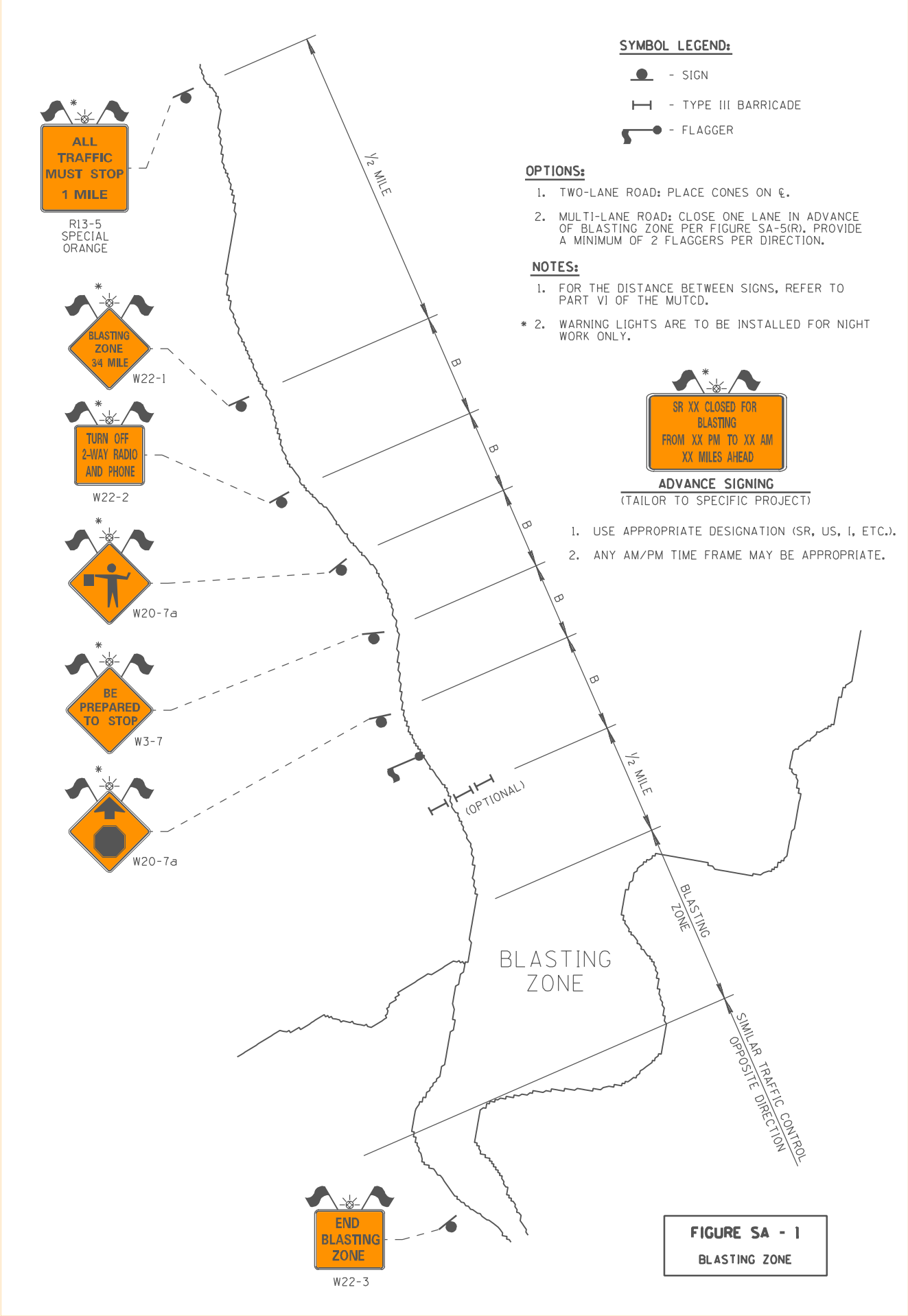


FIGURE SA - 1

BLASTING ZONE

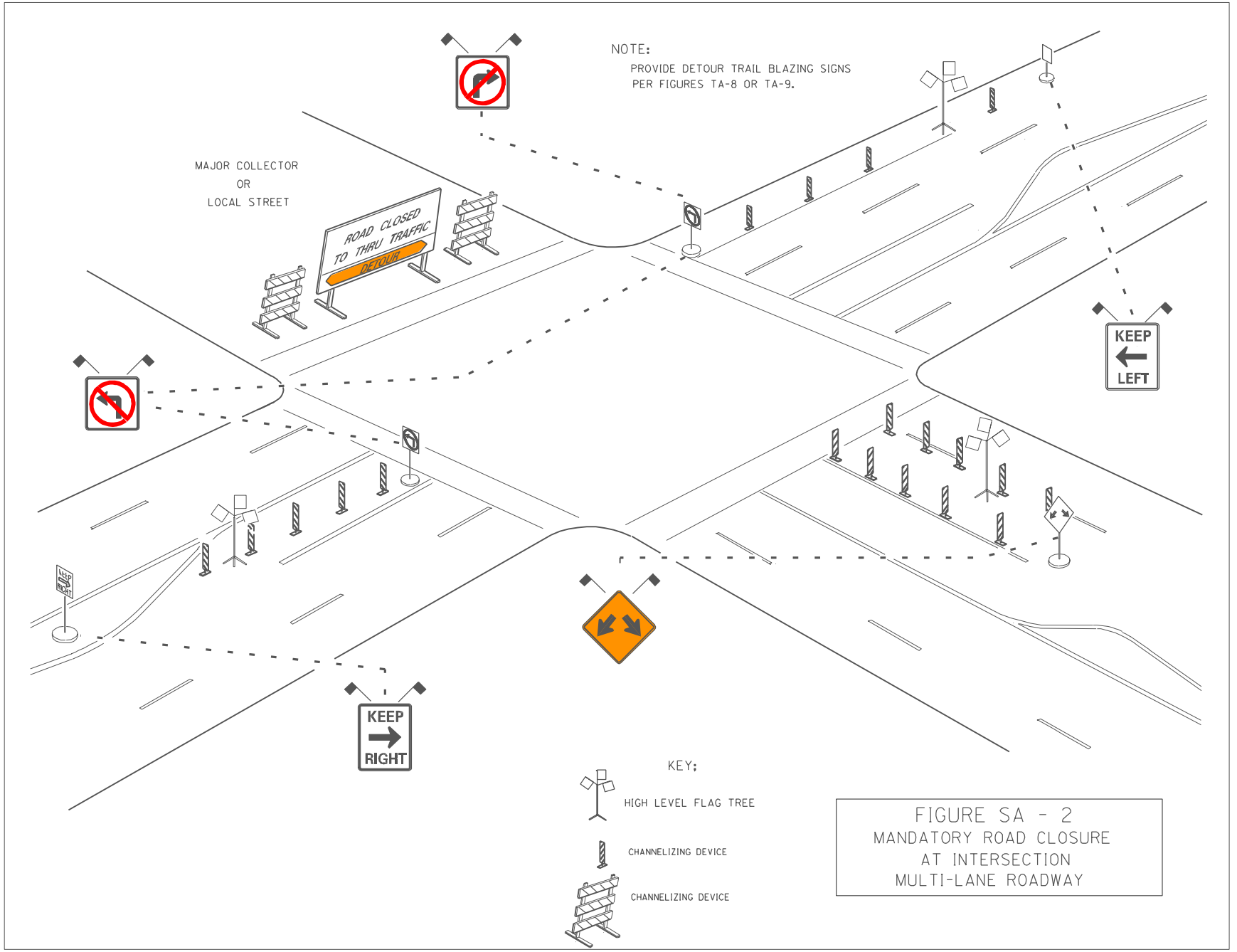
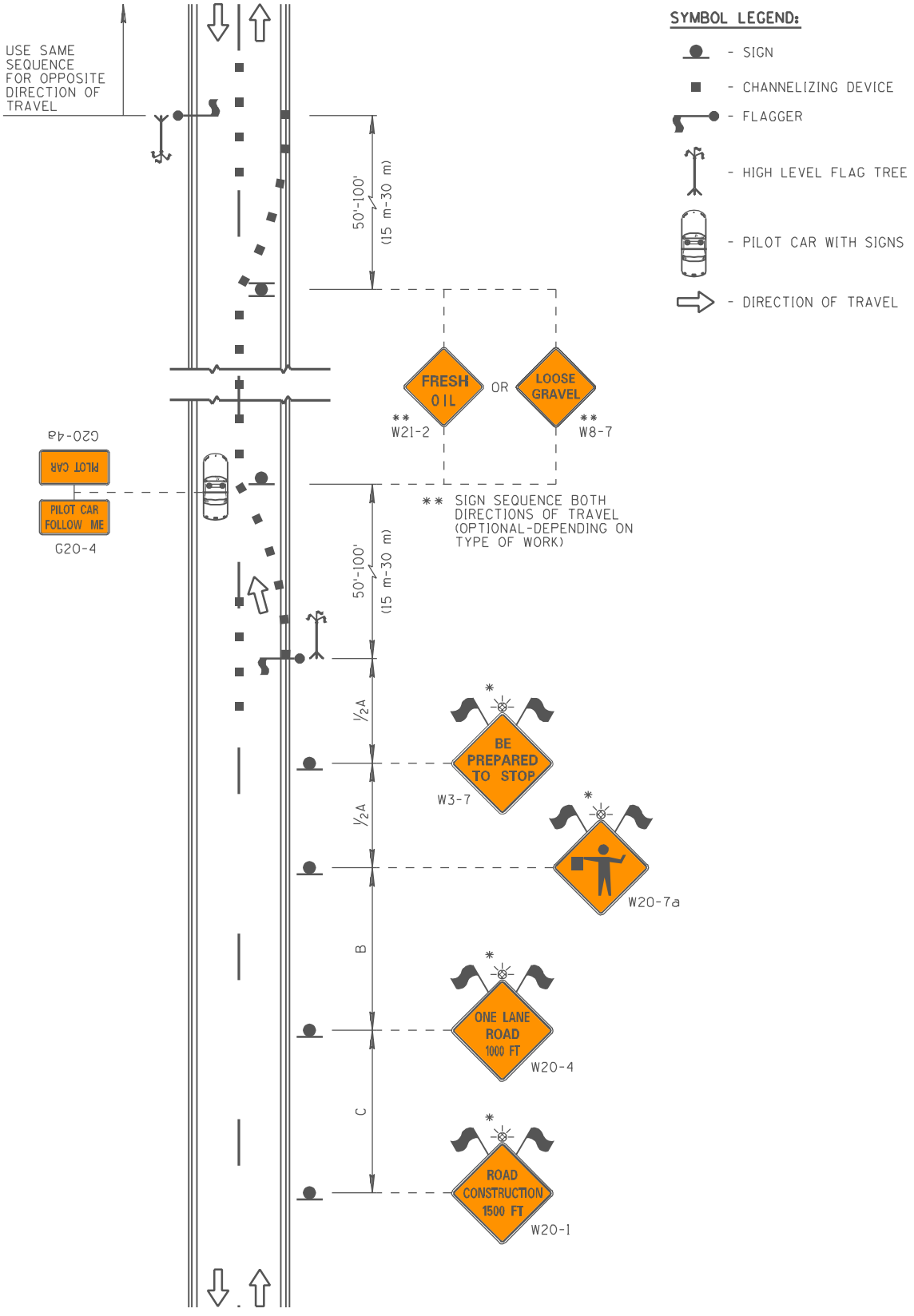


FIGURE SA - 2
MANDATORY ROAD CLOSURE
AT INTERSECTION
MULTI-LANE ROADWAY



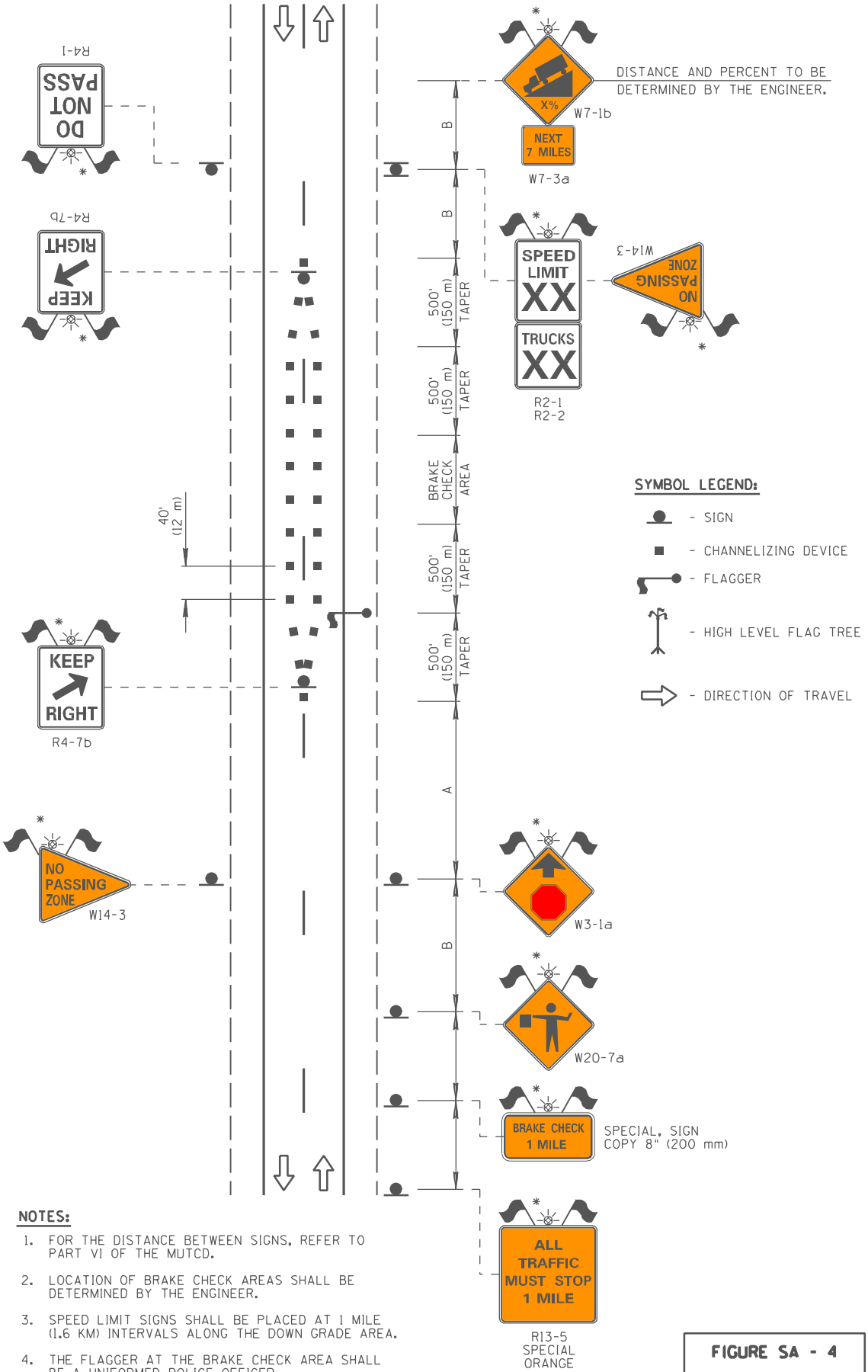
NOTES:

1. FOR THE DISTANCE BETWEEN SIGNS, REFER TO PART VI OF THE MUTCD.

* 2. WARNING LIGHTS ARE TO BE INSTALLED FOR NIGHT WORK ONLY.

FIGURE SA - 3

ONE LANE CLOSURE OF A TWO-WAY ROADWAY UTILIZING PILOT CAR



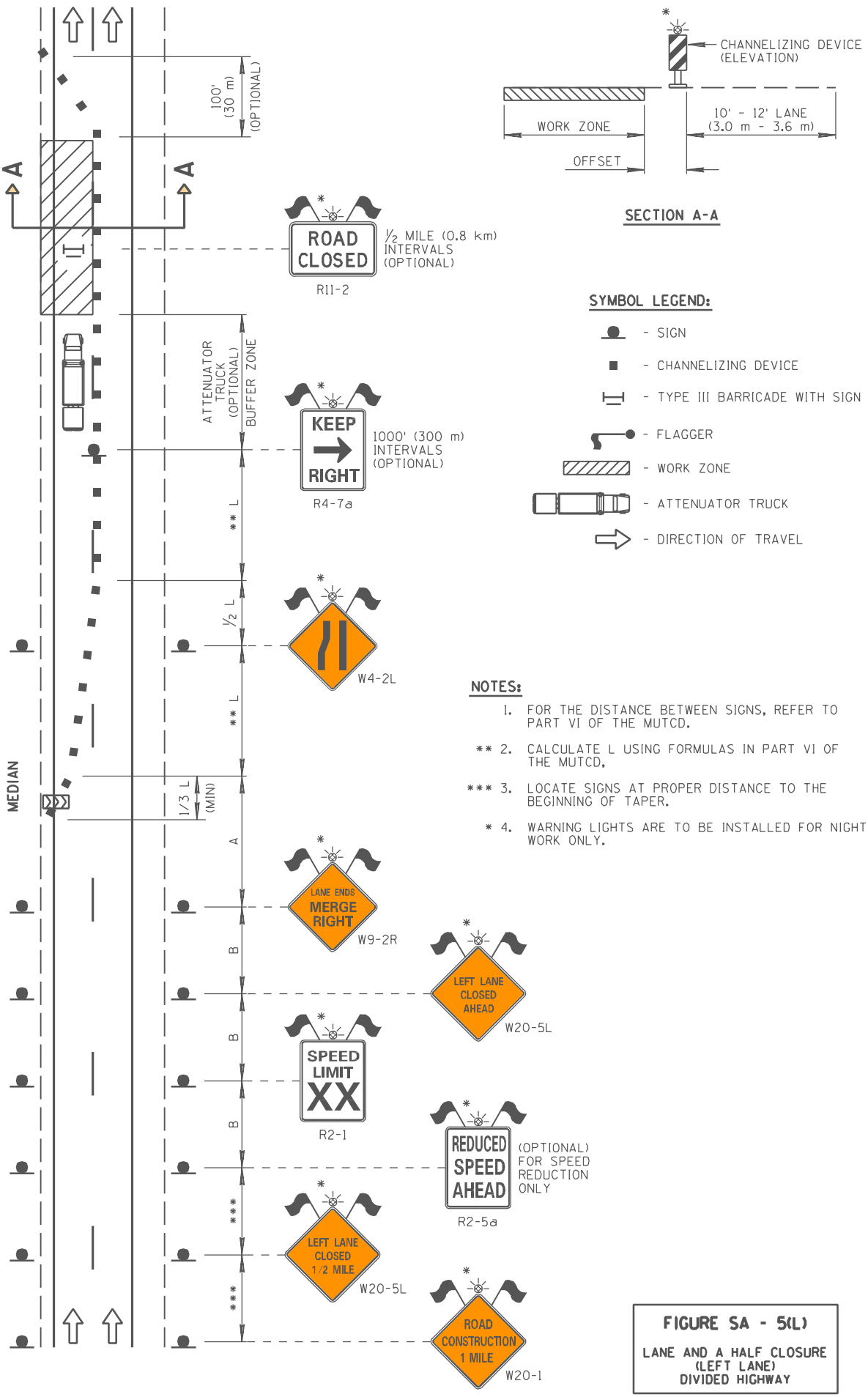
NOTES:

1. FOR THE DISTANCE BETWEEN SIGNS, REFER TO PART VI OF THE MUTCD.
2. LOCATION OF BRAKE CHECK AREAS SHALL BE DETERMINED BY THE ENGINEER.
3. SPEED LIMIT SIGNS SHALL BE PLACED AT 1 MILE (1.6 KM) INTERVALS ALONG THE DOWN GRADE AREA.
4. THE FLAGGER AT THE BRAKE CHECK AREA SHALL BE A UNIFORMED POLICE OFFICER.

* 5. WARNING LIGHTS ARE TO BE INSTALLED FOR NIGHT WORK ONLY.

FIGURE SA - 4

BRAKE CHECK AREA (TWO-LANE, TWO-WAY)

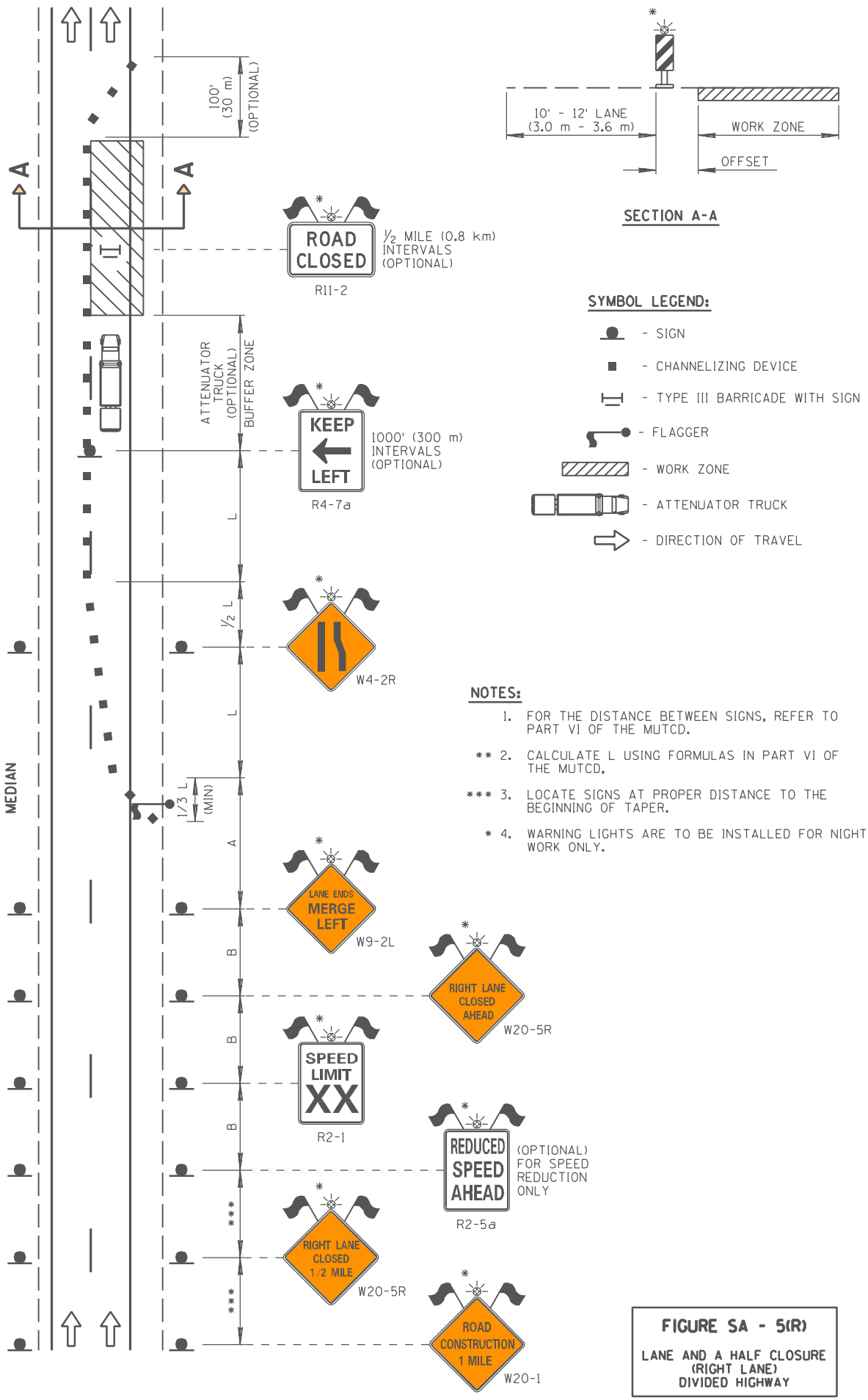


NOTES:

1. FOR THE DISTANCE BETWEEN SIGNS, REFER TO PART VI OF THE MUTCD.
** 2. CALCULATE L USING FORMULAS IN PART VI OF THE MUTCD.
*** 3. LOCATE SIGNS AT PROPER DISTANCE TO THE BEGINNING OF TAPER.
* 4. WARNING LIGHTS ARE TO BE INSTALLED FOR NIGHT WORK ONLY.

FIGURE 5A - 5(L)

LANE AND A HALF CLOSURE (LEFT LANE) DIVIDED HIGHWAY



NOTES:

1. FOR THE DISTANCE BETWEEN SIGNS, REFER TO PART VI OF THE MUTCD.

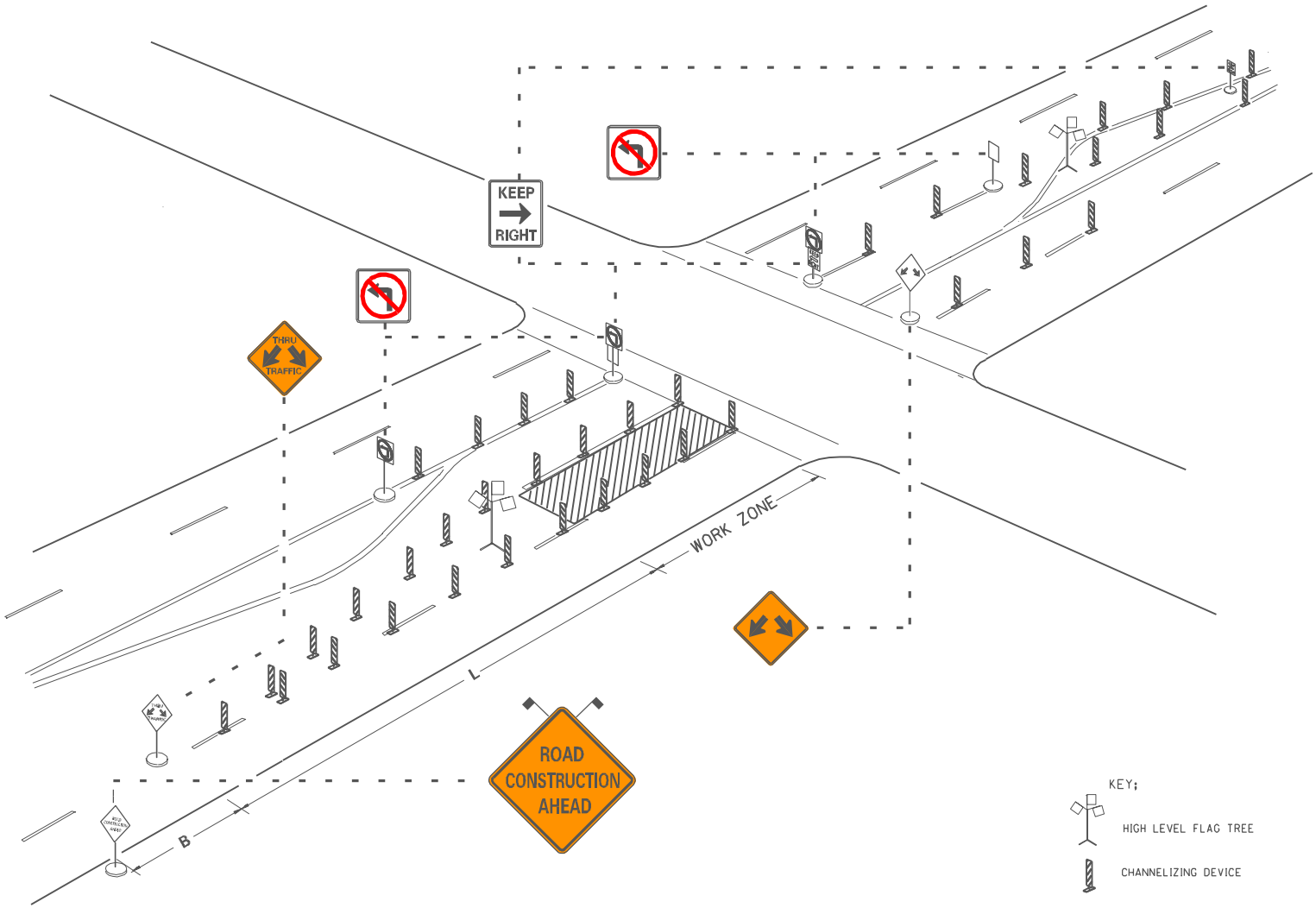
** 2. CALCULATE L USING FORMULAS IN PART VI OF THE MUTCD.

*** 3. LOCATE SIGNS AT PROPER DISTANCE TO THE BEGINNING OF TAPER.

* 4. WARNING LIGHTS ARE TO BE INSTALLED FOR NIGHT WORK ONLY.

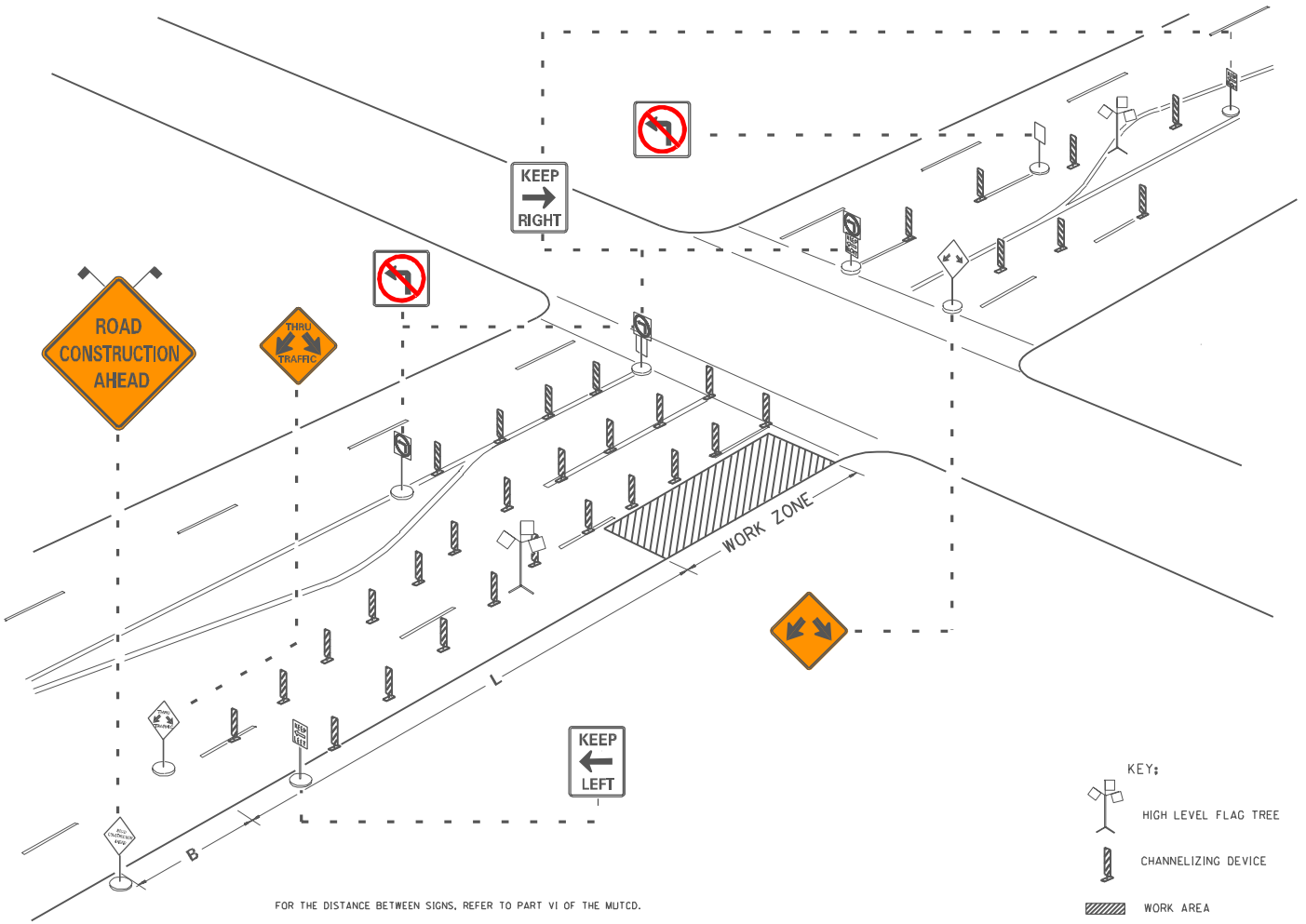
FIGURE SA - 5(R)

LANE AND A HALF CLOSURE (RIGHT LANE) DIVIDED HIGHWAY



FOR THE DISTANCE BETWEEN SIGNS, REFER TO PART VI OF THE MUTCD.

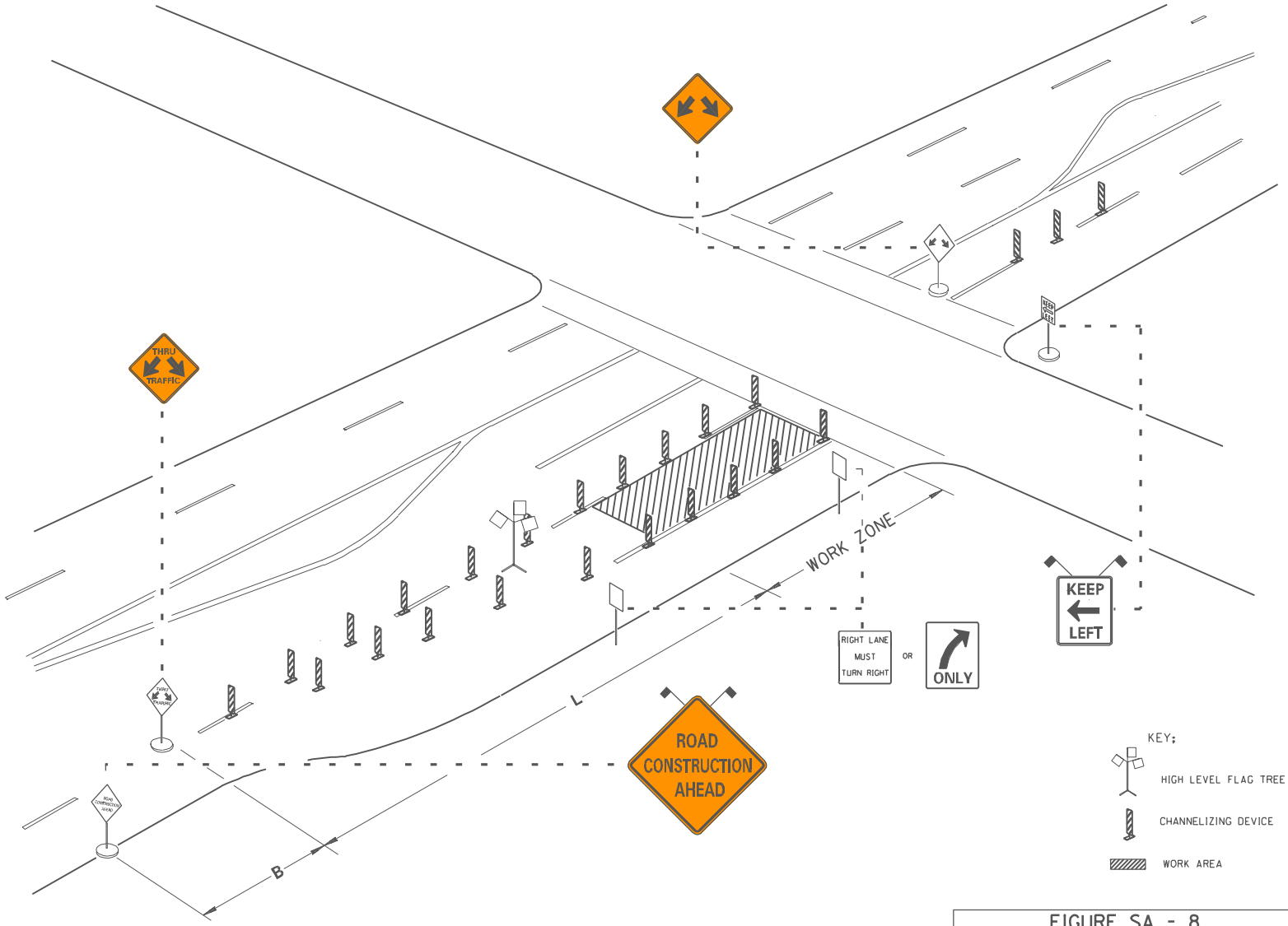
FIGURE SA - 6
DIVERSION OF LEFT THROUGH
LANE ONTO LEFT TURN LANE
DAYTIME CHANNELIZATION



FOR THE DISTANCE BETWEEN SIGNS, REFER TO PART VI OF THE MUTCD.

FIGURE SA - 7

RIGHT LANE CLOSURE WITH LANE SHIFTS USING LEFT TURN LANE DAYTIME CHANNELIZATION



FOR THE DISTANCE BETWEEN SIGNS, REFER TO PART VI OF THE MUTCD.

FIGURE SA - 8

INTERSECTION WITH RIGHT TURN LANE
RIGHT LANE CLOSURE- NEAR SIDE
DAYTIME CHANNELIZATION

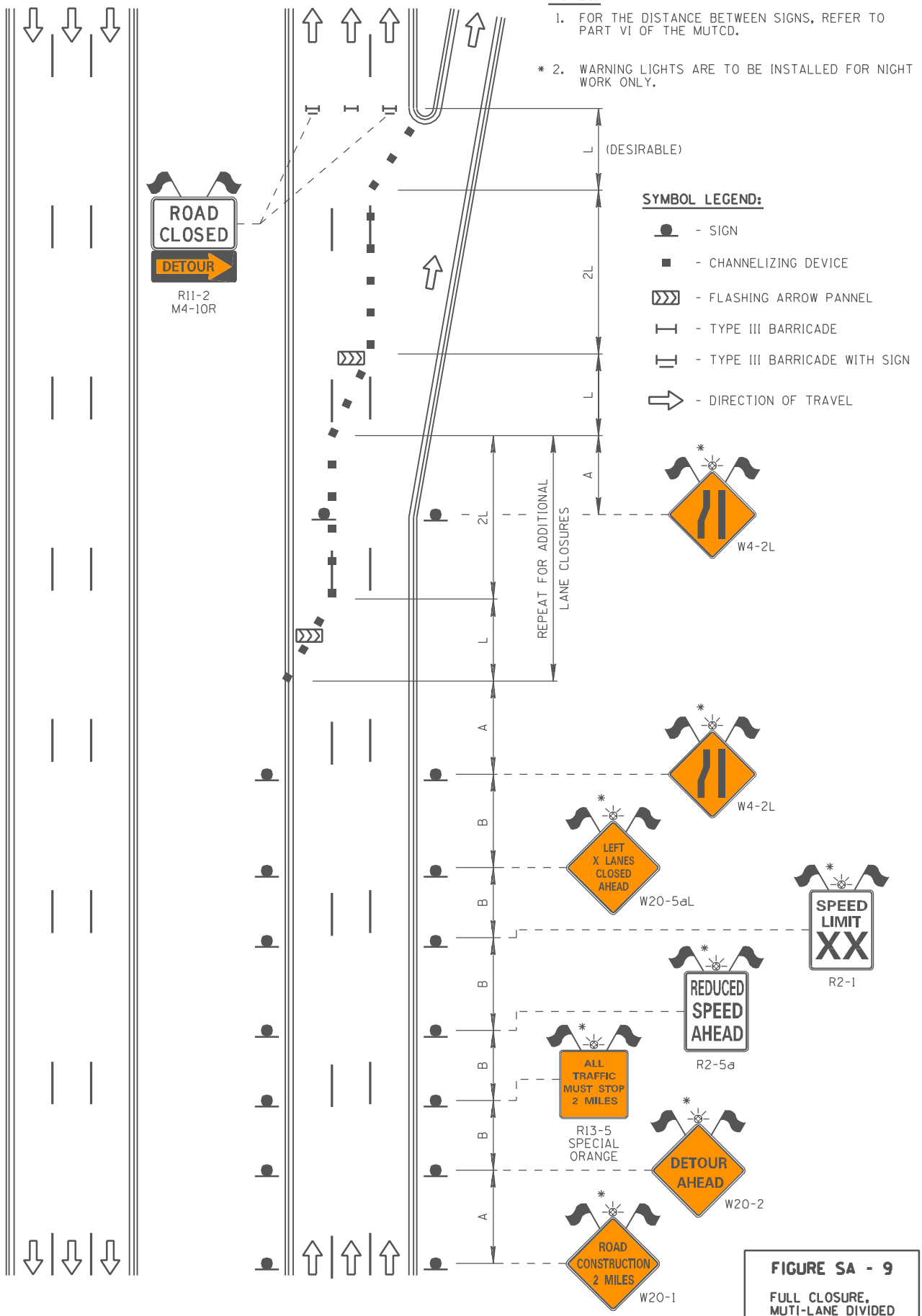
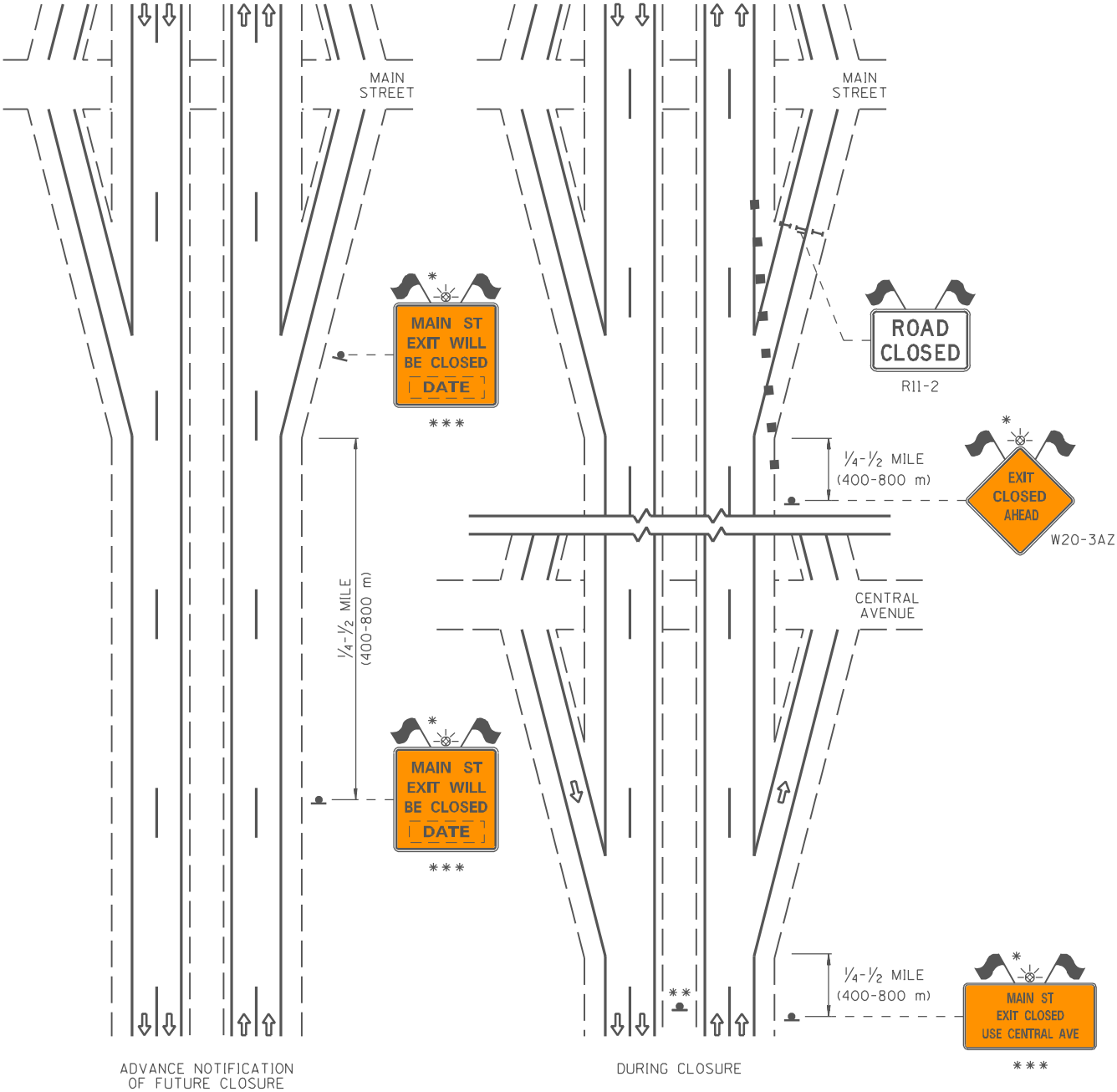


FIGURE SA - 9

FULL CLOSURE, MUTI-LANE DIVIDED HIGHWAY



NOTES:

** 1. MEDIAN INSTALLATION OPTIONAL.

*** 2. SPECIAL, SIGN COPY 8"

* 3. WARNING LIGHTS ARE TO BE INSTALLED FOR NIGHT WORK ONLY.

SYMBOL LEGEND:

- SIGN
- CHANNELIZING DEVICE
- DATE - SEPARATE PANEL(S)
- TYPE III BARRICADE
- TYPE III BARRICADE WITH SIGN & LIGHTS
- DIRECTION OF TRAVEL

FIGURE SA - 10

EXIT RAMP CLOSURE ADVANCED NOTIFICATION AND ACTUAL CLOSURE

NOTES:

1. FOR THE DISTANCE BETWEEN SIGNS, REFER TO PART VI OF THE MUTCD.
2. MEDIAN CROSSOVER FOR CONSTRUCTION VEHICLES SHALL ONLY BE USED WITH APPROVAL OF THE ENGINEER.
3. THE MINIMUM SPACING BETWEEN CONSTRUCTION MEDIAN CROSSOVERS, SHALL BE 1½ MILES (2.4 km).
* 4. WARNING LIGHTS ARE TO BE INSTALLED FOR NIGHT WORK ONLY.

SYMBOL LEGEND:

- SIGN
- CHANNELIZING DEVICE
- FLASHING ARROW PANEL
- CONSTRUCTION VEHICLE
- DIRECTION OF TRAVEL

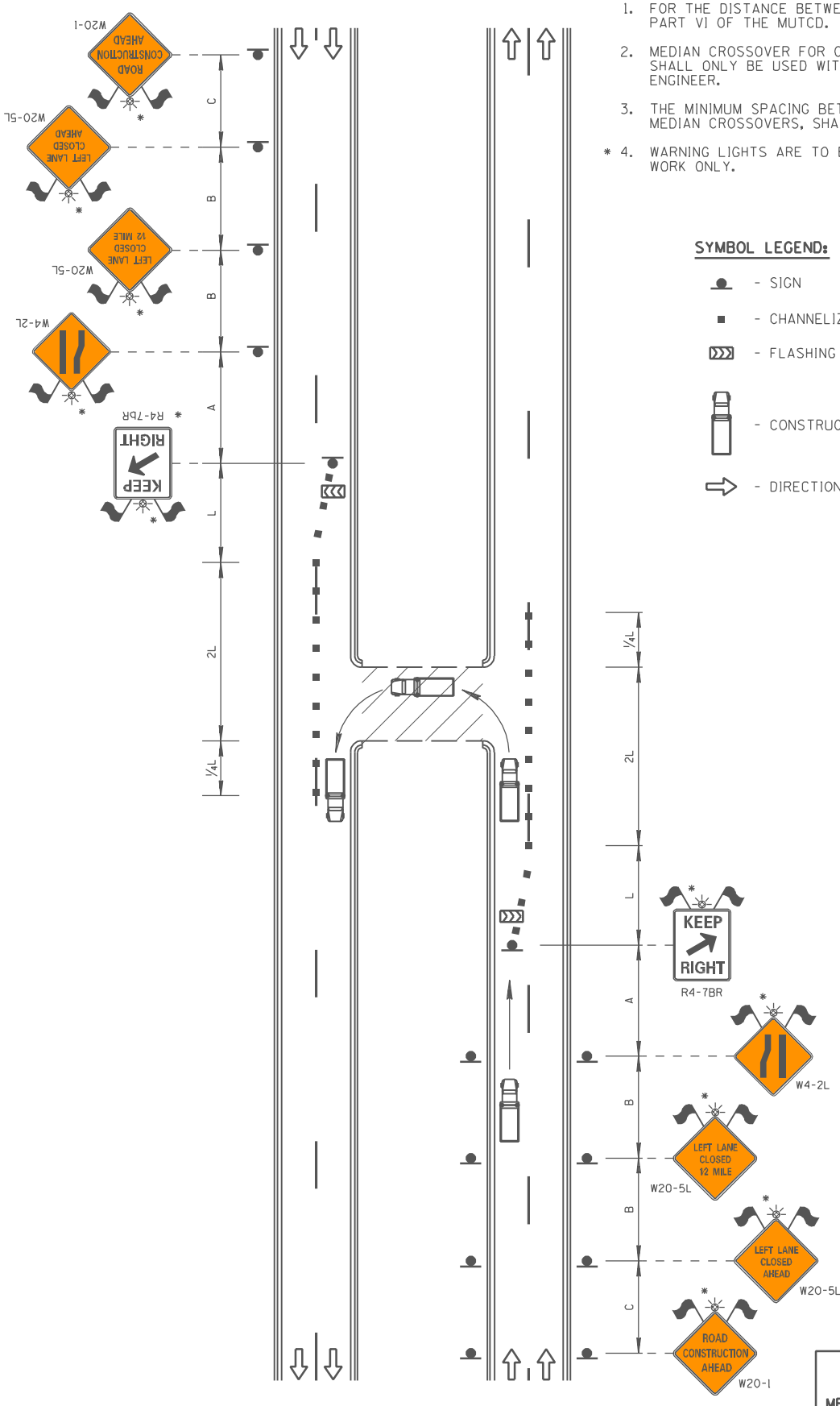
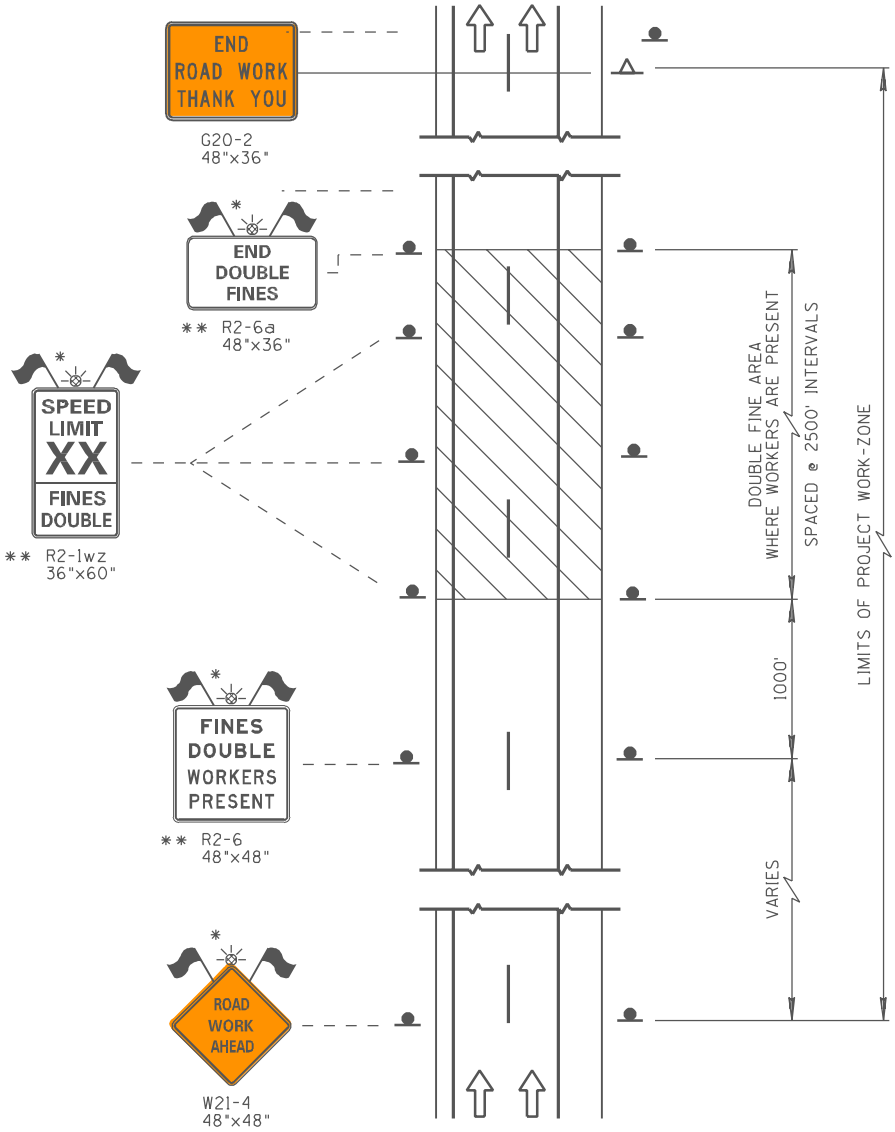


FIGURE SA - 11

MEDIAN CROSSOVER FOR CONSTRUCTION VEHICLES (DIVIDED HIGHWAY)



NOTES:

** 1. THESE SIGNS SHALL BE PLACED ONLY WHEN WORKERS ARE PRESENT IN THE DOUBLE FINE AREA, AND SHALL BE REMOVED IMMEDIATELY WHEN WORKERS ARE NOT PRESENT IN THE DOUBLE FINE AREA. EXISTING SPEED LIMIT SIGNS IN DOUBLE FINE AREA SHALL BE COVERED WHEN THESE SIGNS ARE VISIBLE.

2. THE SPEED LIMIT IN THE DOUBLE FINE AREA CAN BE THE SAME AS THE SPEED LIMIT OF THE ENTIRE PROJECT WORK-ZONE. THE SPEED LIMIT CAN ALSO BE REDUCED WITH JUSTIFICATION PER ADOT TRAFFIC GROUP POLICIES GUIDELINES AND PROCEDURES.

3. MORE THAN ONE DOUBLE FINE AREA COULD EXIST IN THE PROJECT WORK-ZONE LIMITS.

* 4. WARNING LIGHTS ARE TO BE INSTALLED FOR NIGHT WORK ONLY.

SYMBOL LEGEND:

△ - SIGN MOUNTED ON SPRING STAND

⇨ - DIRECTION OF TRAVEL

FIGURE SA - 12

TRAFFIC CONTROL SIGNING: FINES ARE DOUBLE IN THE WORK-ZONE AREA WHERE WORKERS ARE PRESENT.

ADDENDUM TO ADOT MUTCD CHAPTER VI SUPPLEMENT

APPENDIX A

DESIGN OF TEMPORARY CONCRETE BARRIER

ADOT Traffic Engineering has adopted the Roadside Design Guide, published by the American Association of State Highway and Transportation Officials (AASHTO) dated 1989, as the document which describes the acceptable practice and procedure for the design of temporary concrete barrier (TCB). The Roadside Design Guide contains appropriate figures, tables, and formulae needed to provide reasonable protection of the work zone and protection of the motoring public.

Since Temporary Concrete Barrier, in itself, is a roadside obstacle, it should be used judiciously, weighing the hazard posed by the construction activity against the hazard posed by the TCB. In some instances considerable engineering judgement must be exercised in deciding whether the TCB is the most appropriate traffic control device.

LAYOUT PER AASHTO ROADSIDE DESIGN GUIDE

The following figures have been taken from the Roadside Design Guide and are modified to serve the purpose of this supplement as an aid for design. The designer should be familiar with the full text of the Roadside Design Guide to properly apply the values derived from the figures. Figures 5.31 and 5.34 identify all of the elements associated with Temporary Concrete Barrier design.

FIGURE 5.31 APPROACH BARRIER LAYOUT VARIABLES

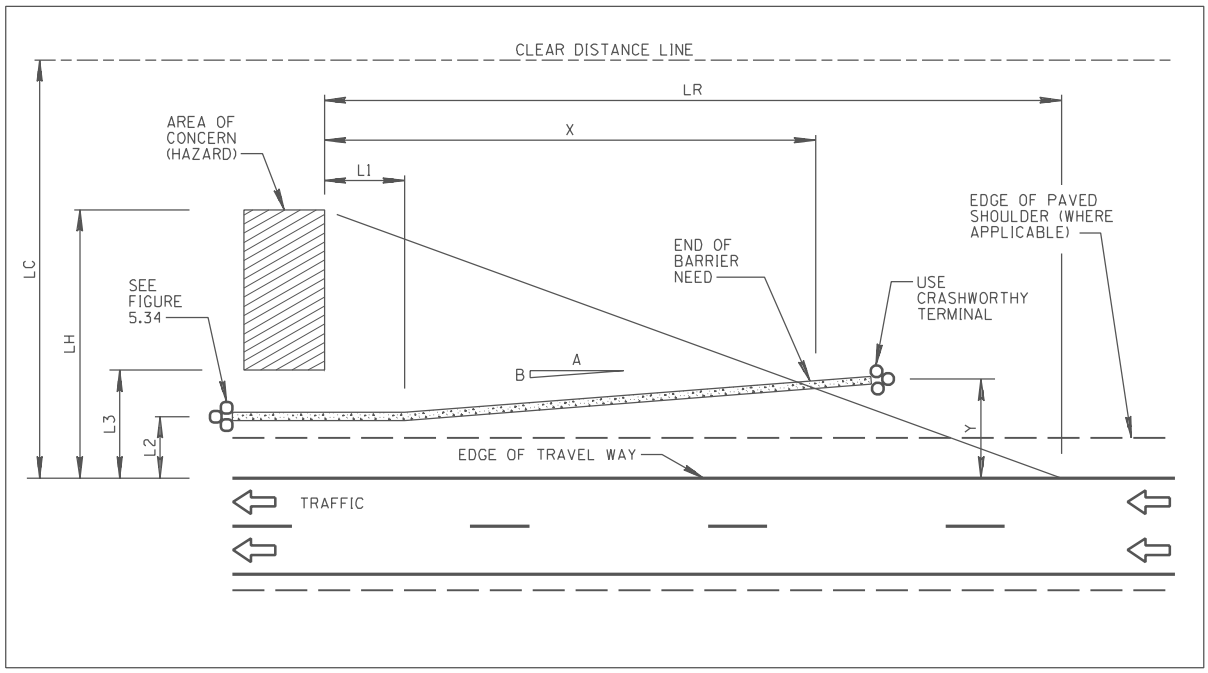
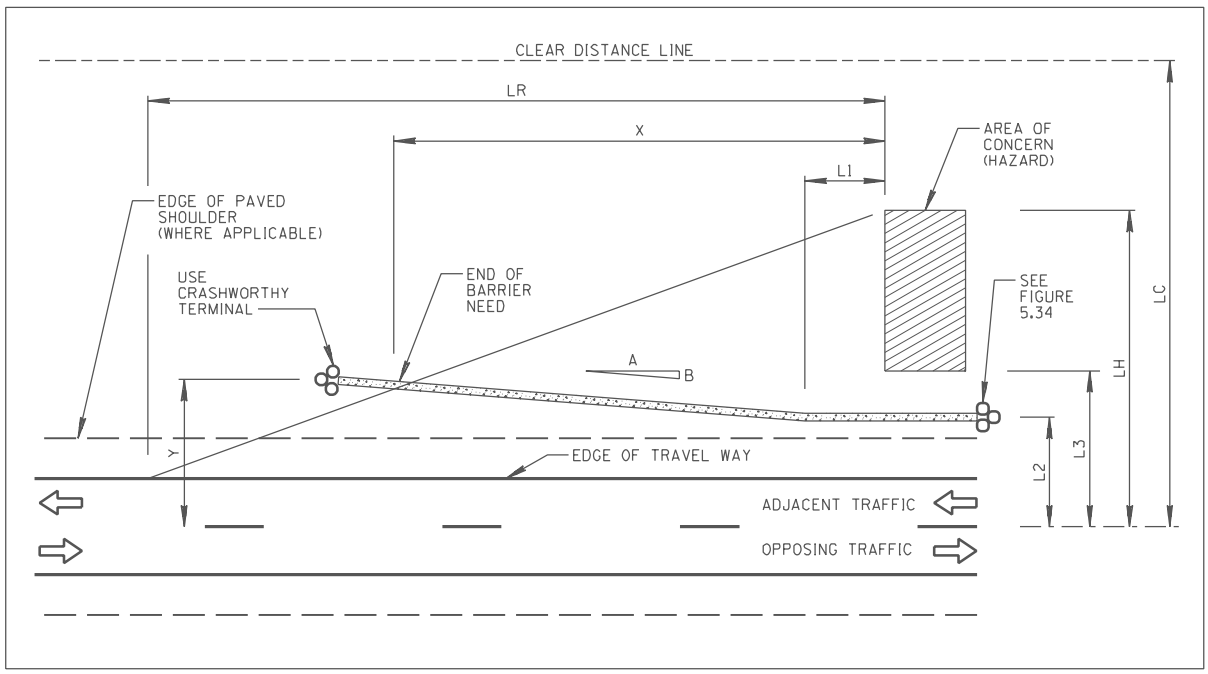


FIGURE 5.34 APPROACH BARRIER LAYOUT FOR OPPOSING TRAFFIC



Temporary Concrete Barrier design is based on length of need (X) and lateral offset (Y). These criteria are dependent on the hazard to be protected and the various elements within the roadway Right-Of-Way as detailed, described and documented in the *Roadside Design Guide*.

The length of need (X) formulae are $X = \frac{LH + (b/a)(L1) - L2}{b/a + (LH)/(LR)}$ and $X = \frac{LH - L2}{(LH)/(LR)}$ respectively, depending on whether the lead-in section is flared or parallel to the traveled way. The lateral offset is described as

$$Y = LH - \left(\frac{LH}{LR}\right)(X)$$

The variables which must be determined are:

L_1 – A buffer distance in advance of the work zone. ADOT Traffic Engineering has established this distance to be 50 feet.

L_2 – The distance from the edge of proposed travel way to the edge of the temporary concrete barrier. The desirable distance should be a minimum of 2 feet , unless field conditions dictate the need for further reduction of this value.

L_H – The distance from edge of travel way to the far side of the clear zone. If the work area hazard extends beyond the clear zone then that dimension shall be used for L_H. In no case shall L_2 exceed the distance to Right of Way. Table 3.1is a copy of the Clear Zone Distances from the *Roadside Design Guide*. Table 3.1 (M) is *the metric version*. The variables to be determined for this table are the design speed prior to roadway construction, the most current Average Daily Traffic (ADT) information, and the shape and slope of the roadway section, as determined by as-built construction drawings, field operations, or field measurements.

TABLE 3.1 Clear Zone Distances (In feet from edge of driving lane)

DESIGN SPEED	DESIGN ADT	FILL SLOPES			CUT SLOPES		
		6:1 OR FLATTER	5:1 TO 4:1	3:1	3:1	4:1 TO 5:1	6:1 OR FLATTER
40 mph or Less	UNDER 750	7-10	7-10	* *	7-10	7-10	7-10
	750-1500	10-12	12-14	* *	10-14	10-12	10-12
	1500-6000	12-14	14-16	* *	12-14	12-14	12-14
	OVER 6000	14-16	16-18	* *	14-16	14-16	14-16
45 – 50 mph	UNDER 750	10-12	12-14	* *	8-10	8-10	10-12
	750-1500	12-14	16-20	* *	10-12	12-14	14-16
	1500-6000	14-16	20-26	* *	12-14	14-16	16-18
	OVER 6000	18-20	24-28	* *	14-16	18-20	20-22
55 mph	UNDER 750	12-14	14-18	* *	8-10	10-12	10-12
	750-1500	16-18	20-24	* *	10-12	14-16	16-18
	1500-6000	20-22	24-30	* *	14-16	16-18	20-22
	OVER 6000	22-24	26-32*	* *	16-18	20-22	22-24
60 mph	UNDER 750	16-18	20-24	* *	10-12	12-14	14-16
	750-1500	20-22	26-32*	* *	12-14	16-18	20-22
	1500-6000	26-30	32-40*	* *	14-18	18-22	24-26
	OVER 6000	30-32*	36-44*	* *	20-22	24-26	26-28
65 - 70 mph	UNDER 750	18-20	20-26	* *	10-12	14-16	14-16
	750-1500	24-26	28-36*	* *	12-16	18-20	20-22
	1500-6000	28-32*	34-42*	* *	16-20	22-24	26-28
	OVER 6000	30-34*	38-46*	* *	22-24	26-30	28-30

*Where a site specific investigation indicates a high probability of continuing accidents, or such occurrences are indicated by accident history, the designer may provide clear zone distances greater than 30 feet as indicated. Clear zones may be limited to 30 feet for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.

**Since recovery is less likely on the unshielded, traversable 1:3 slopes, fixed objects should not be present in the vicinity of the tope of these slopes. Recover of high speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right of way availability, environmental concerns, economic factors, safety needs, and accident histories. Also, the distance between the edge of the travel lane and the beginning of the 1:3 slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the fill slope parameters which may enter into determining a maximum desirable recovery area are illustrated in Figure 3.2 of the *Roadside Design Guide.*

L_R - This is length of runout in feet as determined by the design speed and the ADT. The value is selected from Table 5.6 and is reproduced as an aide for design. For design speeds not show, the value of L_R shall be interpolated.

Table 5.6 Suggested Runout Lengths for Barrier Design

DESIGN SPEED		**Traffic Volume (ADT)**							
		Over 6000		**2000 - 6000**		**800 - 2000**		**Under 800**	
		Runout Length L_R		**Runout Length L_R**		**Runout Length L_R**		**Runout Length L_R**	
MPH	**Km/h**	**Ft**	**M**	**Ft**	**M**	**Ft**	**M**	**Ft**	**M**
70	110	480	146	440	134	400	122	360	110
60	95	400	122	360	110	330	100	300	90
50	80	320	97	290	88	260	79	240	73
40	65	240	73	220	67	200	61	180	55
30	50	170	52	160	49	140	43	130	40

b/a – This is the inverse of the flare rate ratio as suggested in Chapter 9 of the *Roadside Design Guide*. Table 9.1 summarizes the flare rates for various design speeds and is reproduced as an aide for design. For flare rates associated for design speeds not documented in Table 9.1, the flare rate shall be interpolated.

Table 9.1 Temporary Concrete Barrier Design Parameters

Desirable Lateral Offset from Edge of Travel Way*	Mph	Km/h	Ft	M

	40 50 60 70	(65) (80) (95) (110)	5 6.5 8 10	1.5 2.0 2.4 3.0
Flare Rate **	40 50 60	(65) (80) (95)	9 to 1 11 to 1 13 to 1	

*If possible, barrier should be placed beyond the edge of travel way but not more than 15 feet. For restricted conditions, when there are long continuous runs of barrier, lesser offsets may be used. The offsets should be 2 feet or more unless the conditions are extreme.

**Flare lengths shorter than 9 to 1 may be used where experience indicates satisfactory performance.

The placement of the Temporary Concrete Barrier shall meet the following criteria:

The end section must be located outside the clear zone: otherwise, it shall be protected as identified in this Traffic Control manual.

The Temporary Concrete Barrier shall be placed on a maximum grade of 10:1 for its entire length.

Maintain existing surface drainage.